CATEGORISATION OF CATV COAXIAL CABLES

This article (a reprint) looks at categorisation of cables based on their construction. Over the past years, some half truths & rumours have emerged, regarding types of foam dielectrics and properties of welded cables. This article informs the reader of the actual facts.

CATV Co-axial Cable forms the single costliest hardware item installed in a CATV Network. A great deal of thought often goes into the selection of the appropriate cable size. Often, financial constraints dictate both the size and final cable selected. Drop Cable such as RG11 (and all smaller sizes) should not be used on the Trunk line. However given the fairly small size of cable networks, Drop Cables such as RG11 and even RG6 have been installed on small Trunk lines. Other complications arise due to the limited power pass capabilities of inappro-priately selected cable. This article examines some lesser known features and cable properties. These properties never-the-less play a significant role in satisfactory long term operation of the Cable distribution plant.

TYPES OF FOAM CABLE

The BIS specifications have given a clear mandate and approval of Foam Cables. The specifications which have been formally declared in October 1995 require that all Cables used in CATV Networks must conform to the relevant BIS specification within a 3 year period i.e. not later than October 1998. While the debate over use of Air Dielectric Cables remains somewhat unresolved, clearly, Foam Dielectric Coax Cable are categorically approved by the BIS. Foam Cables can be categorized by the method used in manufacturing the Foam. Both methods start out with the use of Polyethylene., which is heated beyond its melting point. Molten Polyethylene is foamed or bubbled either chemically or using a gas injection process. Lets look at both these options -

CHEMICALLY FOAMED CABLES

In this process a chemical additive is added to the Molten Polyethylene. This chemical additive decomposes to give off nitrogen gas, when it comes into contact with the hot, molten polyethylene. This nitrogen gas forms bubbles. The mixture is quickly extruded (drawn out in the shape of a tube) and cooled so as to permanently trap the tiny nitrogen bubbles within the polyethylene, which solidifies when cooled. The nitrogen bubbles should all be of a small, uniform size, tightly packed together. Most International Foam Cable manufacturers used the chemical foam process a few years ago. Cables manufactured by this process exhibit good characteristics, if made under strict quality control and supervision. Nevertheless, some batches exhibit an increase in the Dielectric loss over a period of time. It is felt that the poor aging performance of chemically foamed cables is due to the long term degradation of the remaining, residual foaming agent added to the polyethylene.

Several small scale manufacturers have evolved their own chemical process. Some of these cables have deteriorated rapidly after installation. The cable either powders or losses increase sharply within a few months. This is probably due to the use of either an inappropriate foaming agent, excessive quantity of foaming agent used or improper control of the process parameters, such as temperature or pressure. Unfortunately a few of these, poor quality products have created a bad image for chemically injected foam cables, in the Indian market.

GAS INJECTED FOAM

To provide consistently high yields and tighter quality control measures, Commscope evolved the Gas Injection process. In this process Nitrogen gas is cooled to below approximately -170 degrees Centigrade. At such low temperatures, nitrogen turns into a liquid. This liquid nitrogen flow, can be very precisely controlled. The liquid nitrogen is injected into the hot molten polyethylene. On contact, liquid nitrogen instantly vaporizes back into gas and forms a large number of tiny air bubbles. The amount and size of the air bubble can be closely controlled by regulating the process

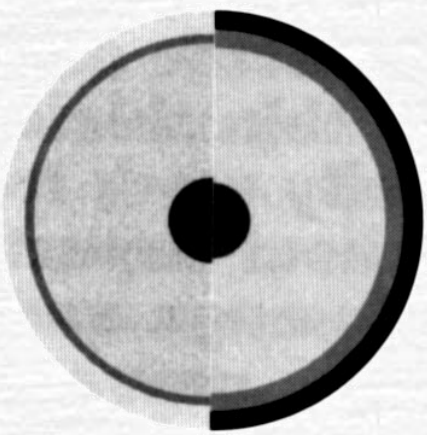
parameters such as the pressure, amount of liquid nitrogen injected, the extrusion speed and the temperature of the molten polyethylene. Careful control of the process can ensure uniform foam bubble size across the entire cross section of the Dielectric, from the center conductor to the outer Shield. Since nitrogen vaporizes much below even room temperature, there is absolutely no possibility of any residual additive, once the cable is extruded. Further, moisture is also eliminated from the liquid nitrogen and consequently the Dielectric, since it would freeze out much before the nitrogen gas liquifies. Gas Injected Foam Cable is currently considered the most advanced process and widely adopted by International manufacturers. However due to the high amount of process complexity and cost of equipment, it is doubtful whether any Indian company has commenced manufacturing the Gas Injected Foam Dielectric, in-house. (Recent reports indicate that Finolex & NG Electronics have installed Gas Injected Foam manufacturing faci-lities).Wherever Gas Injected Foam Dielectric is utilized it is probably, of imported origin. Unfortunately, for the end user, there is no simple method to tell whether a foam cable has been manufactured using Chemicals or by gas injection.

TRUNK CABLE TECHNOLOGIES

Trunk Cables are manu-factured with a continuous tube as the sheath. Trunk Cables can be categorized based on the construction of the outer shield /tube. There are two types of manufacturing processes.

SEAMLESS TUBULAR CABLES

These cables are manu-factured in a novel, method. A metal tube or pipe of thin aluminum is extruded. The pipe is usually several hundred meters long. Usually, a single tube would have a length of almost 700 meters. The tube is made to a diameter slightly larger than the Dielectric, permitting the Dielectric with a bonded Center Conductor to be easily inserted inside the tube. The Dielectric and center conductor are usually kept longer than the aluminum tube. This aluminum tube is then extended between two buildings, in a straight line, extending a bit more than the full 700 meters. The aluminum tube is then fixed at one end and pulled at the other. This reduces the tube diameter until it fits tightly onto the Dielectric. The process requires 2 buildings separated by a distance of more than 700 meters, with an area in-between where the cable is stretched.



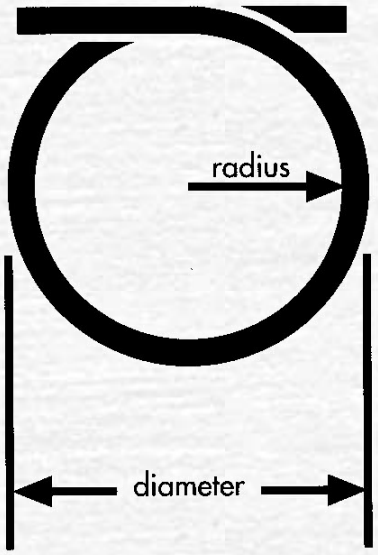
Though this process may seem simple, several complications arise in practice. The aluminum tube has a thickness of approximately 0.6mm (for the 500 series Trunk Cable) and a tube several hundred meters long is to be manufactured and laid out without damage for this rather delicate assembly. The traction or pulling force applied should ensure that the tube elongation is uniform throughout the cable span. Any rupture of the tube during elongation would result in rejection of the entire length. An interesting result of this process is that Seamless Cables can only be made to a fixed length. If a longer maximum length is to be manufactured, the two buildings will have to be moved further apart - clearly making this an impossible proposition! Hence Seamless Trunk Cables are available only in a specific maximum length. The Alcatel ACE500 or Commscope's P3 500 Cable are examples of Seamless Trunk Cables.

WELDED TUBULAR CABLES

In these Cables, the outer tube is made by a continuous process of folding a thin sheet of aluminum around the Dielectric and welding the two open edges together. An obvious benefit is that the Cable can be manufactured to any desired length. Usually a much thinner aluminum sheath is used for Welded Cables than for Seamless Cables. The Commscope QR540 Series and the Alcatel ACW540 Series are typical examples of Welded Tubular Cables. Given the fact that Welded Cables necessarily contain a joint running along the entire length of the cables and the fact that the sheath is much thinner (approximately 0.3mm for half inch Trunk Cables), some users are concerned about the mechanical robustness of the Cable and its electrical as well as mechanical uniformity. It is interesting to compare the properties and the applications for each of these two types of cables. The author contacted both Alcatel Cables - Belgium as well as Commscope Cables - USA for their feed-back. To summarize, there is clearly no specific cable that is superior, between seamless and welded cables. Each of these products have their advantages and disadvantages.

Seamless Trunk Cables are usually, more flexible. While flexibility is usually directly associated with a smaller bending radius, this is not necessarily true. The table above gives a comparison of the bending radius for both Seamless and Welded Trunk Cables. As indicated in the chart, it is

apparent that the jacket bonding plays a more important role on the bending radius, rather than whether the cable is Welded or Seamless. Flexibility really indicates the ease with which a cable can be bent particularly, over a longer length such as 10 meters. The bending radius clearly indicates how tightly a cable can be wrapped without mechanical damage.



Correspondence with Alcatel - Belgium indicates that Alcatel, Belgium (earlier Cablerie Sene ffoise which in turn, has now been acquired by Commscope) developed its range of Welded Cable to facilitate easy laying in winding ducts underground. This method is intensively used in the UK and was a critical requirement there. The Welded Cable is more flexible but does not permit a large pulling force (tension) during installation. This could sometimes cause problems when pulling through narrow ducts. The Seamless Tube Cable is stronger and this property has often resulted in its use even underground. Another concern that the author came across was that welded cables were supposed to be more prone to failure due to continuous , small vibrations, such as those caused due to oscillations or swaying in the wind. This would be particularly a concern for overhead suspended cable spans, as used in India. The greatest risk would be in coastal towns, with a strong wind, and installations using large cable spans , such as between 2 tall buildings. Commscope dispels any such concern for its Welded cable (QR Series). They confirm that their welded cable has been used over very large spans, freely suspended over canyons, in the USA. Such span are subjected to high wind velocities, large temperature changes, dust erosion and a host of other hostile conditions. Welded Cables have withstood the test of time.

Further, Mr. Michael Ellis, at Commscope, USA dispels any concerns regarding the electrical and mechanical non uniformity of their welded cables. The outer welded tube is tested for complete electrical uniformity by passing eddy currents and measuring any current crowding along the weld. A uniform flow of current across the entire outer tube conclusively tests the electrical uniformity of the shield. To test its mechanical characteristics Commscope subjects its Welded Cable to more than 2.5 times the maximum recommended pulling tension. There should be no mechanical failure of the Cable even at this high stress. The cable is then stretched until it physically ruptures. Commscope ensures that the rupture takes place at any point across the cross section, except at the weld ! This conclusively tests that the weld is the strongest, not weakest portion of the tube.

CONCLUSION

The past years have seen a proliferation of local manufacturers of foam cables. Most of these utilise the Chemical process. While the chemical process can yield an excellent product, it needs strict process control and proper selection of the chemical foaming agent. This information is usually held as a closely guarded secret, by cable manufacturers. Hence most cable manufacturers go through a learning curve to develop their products. Unfortunately, some manufacturers have marketed products which were not perfected. These products deteriorate rapidly within the first six months. Unfortunately the cable operator has often had to bear the brunt. Chemical Foam Cables manufactured in the country are now often of good quality. However the cable operator must exercise caution before buying. Its best to check with your dealer or other cable networks on which products have withstood the time.

Choice of Seamless and Welded Trunk Cables is less straight forward. Leading manufacturers claim different properties and applications for their products. However it clearly emerges that contrary to popular belief, welded cables do not offer inferior electrical characteristics or weaker mechanical properties in most applications. Welded Cables are suitable for overhead use, as clarified by a leading international manufacturer. Welded Cables are usually manufactured in slightly larger sizes than comparable Seamless Cables (eg: 540 series compared to 500 series). The larger cable diameter of the welded product automatically provides it a lower loss, this lower loss as well as the usual packing length for the 540 series often make it a good choice when considering cable losses at 550 MHz, and amplifier gain. The packing length closely matches amplifier gain to the cable loss of the 540 series, this minimises the need to cut the cable further, ultimately resulting in cable cut pieces which cannot be put to use efficiently.